

## PROJECT SUMMARY

## CALIFORNIA POLYTECHNIC STATE UNIVERSITY, SAN LUIS OBISPO

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California Polytechnic State University's design project for the 1990/91 school year was the design of a close air support aircraft. There were eight design groups that participated and were given requests for proposals. These proposals contained mission specifications, particular performance and payload requirements, as well as the main design drivers.

The mission specifications called for a single pilot weighing 225 lb with equipment. The design mission profile consisted of the following:

1. Warm-up, taxi, take off and accelerate to cruise speed.
2. Dash at sea level at 500 knots to a point 250 nmi from take off.
3. Combat phase, requiring two combat passes at 450 knots that each consist of a 360° turn and an energy increase of 4000 ft. At each pass, half of air-to-surface ordnance is released.
4. Dash at sea level at 500 knots 250 nmi back to base.
5. Land with 20 min of reserve fuel.

The request for proposal also specified the following performance requirements with 50% internal fuel and standard stores:

1. The aircraft must be able to accelerate from Mach .3 to .5 at sea level in less than 20 sec.
2. Required turn rates are 4.5 sustained g at 450 knots at sea level. A 6.0 instantaneous turn rate was also required at the same conditions.
3. The aircraft must have a reattack time of 25 sec or less. Reattack time was defined as the time between the first and second weapon drops.
4. The aircraft is allowed a maximum take off and landing ground roll of 2000 ft.

The payload requirements were 20 Mk 82 general-purpose free-fall bombs and racks; 1 GAU-8A 30-mm cannon with 1350 rounds; and 2 AIM-9L Sidewinder missiles and racks.

The main design drivers expressed in the request for proposal were that the aircraft should be survivable and maintainable. It must be able to operate in remote areas with little or no maintenance. Simplicity was considered the most important factor in achieving the former goal. In addition, the aircraft must be low cost both in acquisition and operation.

The following are the summary of the aircraft configurations developed by the eight groups.

## THE SNODOG

With the design mission profiles and objectives discussed above in mind, we would like to present the future of close air support: the SnoDog. Configuration results are summarized in Fig. 1. This highly maneuverable aircraft has a low-aspect-

ratio, 20° aft swept wing incorporating a supercritical airfoil for low weight and larger fuel volume. The SnoDog has twin low-bypass turbofan engines, twin booms, two canted vertical stabilizers, a high cross-mounted horizontal stabilizer, and minimal avionics. The cost per aircraft is \$14.8 million.

For the SnoDog, a low, conventional wing with a supercritical airfoil was chosen. The placement of the wing was made to facilitate ordnance accessibility, to enhance maintainability, and to reduce the length of the landing gear struts. Structurally, a low wing allowed for spar carry-through to occur with minimal internal interference. In addition, the wing spars are used to help support the engines. Although visibility is not as good as with a high wing position, the SnoDog's wing is placed as far aft as possible to maximize visibility. An aspect ratio of 6 was selected as a compromise between the better aerodynamic performance of a high-aspect-ratio wing and the low cost, simplicity, and desirable ride qualities of a low-aspect-ratio wing. The wing is swept aft 20° to increase the critical Mach number. This also allowed the wing to be thicker, thus reducing the wing weight and creating ample space to store most of the SnoDog's fuel.

The cockpit and engines for the SnoDog are contained in a conventional fuselage. The empennage, however, is supported by twin booms. This configuration was selected for several reasons. A conventional fuselage was needed to provide the internal area necessary for the pilot, internal systems, and cannon. Twin booms, however, are lighter structurally than a conventional fuselage (although a slight drag penalty is paid). Having twin booms allowed complete separation of the redundant control systems, a survivability feature. Finally, engine accessibility is greatly enhanced. The engines can be pulled straight out of the back without any empennage interference.

For the SnoDog, two vertical stabilizers were used, canted inward 12°, coupled with a high cross-mounted horizontal stabilizer. The location of the horizontal tail was selected to keep it out of the hot jet exhaust, to keep it in the freestream flow at high angles of attack, and to facilitate engine removal. The twin vertical tails are a survivability feature: the SnoDog can fly with one stabilizer severely damaged.

The SnoDog's twin low-bypass turbofan engines are located above the wing and to the rear of the fuselage. Each engine has its own inlet located above the wing and surrounding the fuselage. This inlet placement minimizes foreign object damage (FOD) and reduces the amount of cannon exhaust gases ingested. Two engines were selected to increase survivability (the SnoDog is capable of flying with one engine out) and to achieve the thrust needed with minimum engine size. The engines are placed close together to minimize the differential

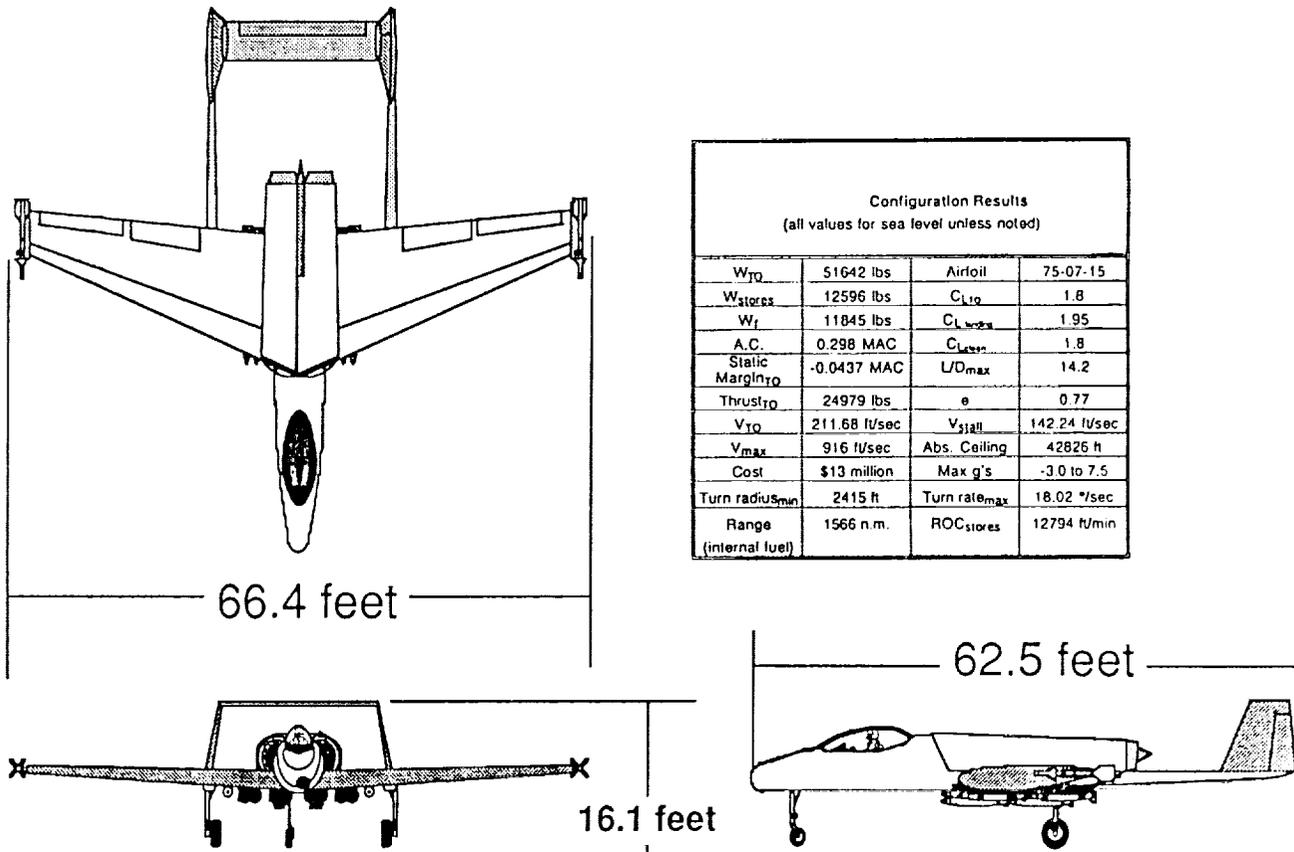


Fig. 1. SnoDog.

thrust in an engine-out situation, and are separated by a Kevlar shield to help contain a catastrophic engine failure.

Design analysis indicates that the SnoDog meets or exceeds all mission requirements. The primary design driver for the SnoDog, simplicity, has resulted in a highly maneuverable, highly survivable, low-cost aircraft. Two advanced design concepts were used. First, the inherent instability of the aircraft necessitates a fly-by-wire system. Secondly, the SnoDog employs a supercritical airfoil. The SnoDog uses proven combat avionics, balancing mission needs and low cost. Finally, the SnoDog uses conventional structural technology, and uses practically no composites to increase maintainability.

#### THE GUARDIAN

The close air support role is a highly specialized role for an aircraft to perform. The plane must be more maneuverable, more survivable, and more easily maintainable than other fighter aircraft. The Guardian was designed with the intention of meeting all these CAS requirements using innovative methods.

The first aspect one would notice in observing the aircraft is its unique configuration, Fig. 2. The configuration layout was designed with survivability and maintainability in mind. The rear

wing/forward canard placement gives the pilot better visibility of the ground, as well as increased maneuverability over conventional designs. The canard-wing configuration makes the Guardian more maneuverable and hence more survivable. The canard serves a multipurpose role of providing horizontal attitude control, gun exhaust control, and wing stall prevention. Stall prevention is critical in close air support operations where the plane is operating close to the ground. The other advantage of a canard as opposed to an elevator is that it is a lifting surface, much like the wing. The canard was placed low in order to keep canard downwash from interfering with the engine inlets as much as possible.

The engines are rear mounted above the wing. The wings themselves provide the engines with protection from ground fire. Engines were placed far enough forward on the top of the wing so as to mask most of the exhaust infrared signature from enemy heat-seeking weapons below. The engine nacelles were not completely buried in the fuselage in order to provide easier access to the engine compartment for maintenance in front-line operations. The twin vertical tails are designed for redundancy as well as additional protection for the engines against weapons fire, and as a heat signature mask.

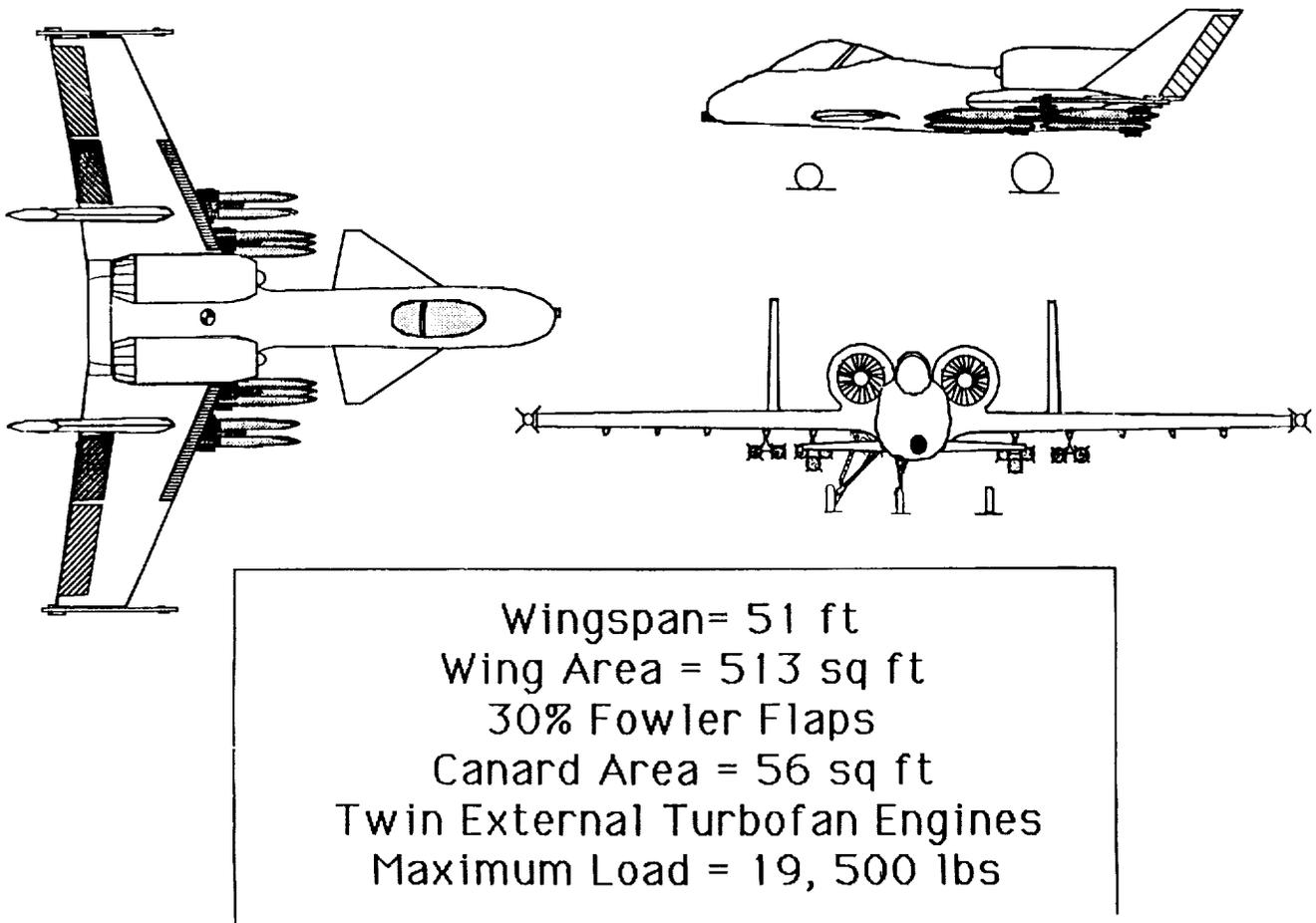


Fig. 2. Guardian CAS.

The propulsion system was designed with simplicity and cost efficiency in mind. The Guardian is one of the two California Polytechnic designs not to use afterburning engines. It was decided not to employ augmented engines in the final design. Although augmented engines provide the advantage of smaller size and weight for the same thrust-to-weight ratio, the fuel consumption was considered unreasonable. The design requirements specified the aircraft to have a 500-n.m. attack radius at an attack speed of 500 knots, about Mach 0.76. An engine that must dash at augmented power settings would require far more fuel to meet the range requirements. Thus, a low-bypass-ratio turbofan engine was selected.

The Guardian's onboard systems were designed to help reduce the pilot's workload as much as possible, as well as keep it up to date in the high-tech environment of the future. The systems include a fly-by-wire flight control system with electrically controlled hydrostatic actuators, using HOTAS flight control, LANTIRN targeting and navigation system, onboard electronic counter measures, a passive radar warning receiver, and a full complement of communications.

Ground support requirements were kept to a minimum. By implementing a fly-by-wire flight control system, a hydraulic charging system is not needed on the ground. Since the aircraft

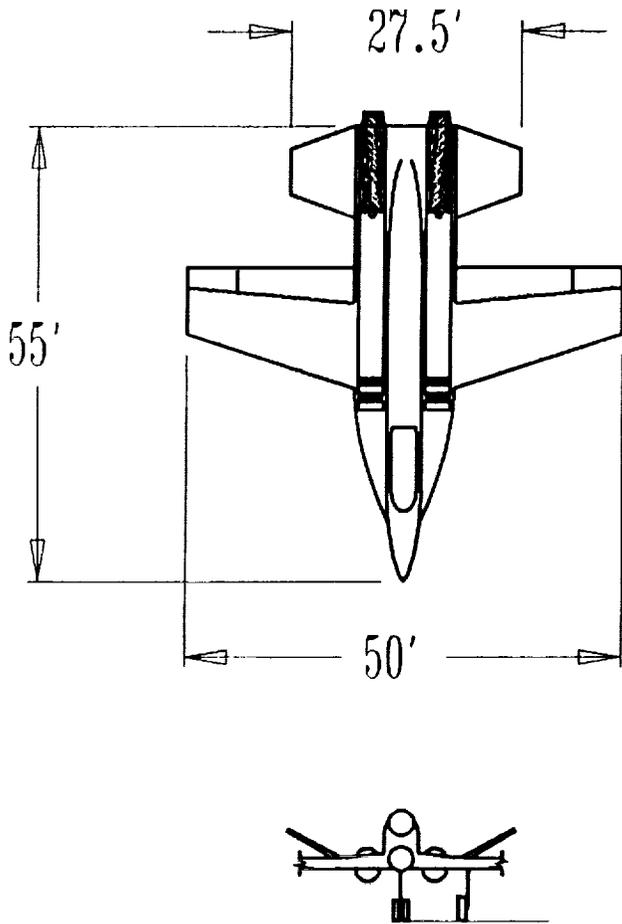
carries an onboard auxiliary power unit, ground-based electrical sources are not needed. The only necessary ground support needed is a fuel source, a GAU-8 cannon reload cart, a liquid oxygen cart, and a powered hoist to mount ordnance to the underside of the wing. Reloading points are placed so as to allow all ground operations to occur at once without any single operation interfering with another.

Every attempt was made to make manufacturing as simple and cost effective as possible. Linear tapered wing spars and the external placement allows for simpler and more cost effective manufacturing. Composite materials were not used extensively because of difficulty in maintenance in the field and cost of manufacturing.

Close air support is primarily the protection of ground forces. With an aircraft designed as survivable, maintainable, rugged, and reliable as this, ground troops can feel at ease knowing that the Guardian will be watching over them, day and night.

#### THE A-2000

The A-2000 is a futuristic attack aircraft capable of delivering massive firepower in the highly lethal arena of modern combat, Fig. 3.



	Differential Stabilizer	
	Wing	(one tail only)
Area (ft <sup>2</sup> )	600.0	75.3
Span (ft)	50.0	9.12
MGC (ft)	12.44	8.56
Aspect Ratio	4.17	1.11
LE Sweep (deg)	17.8	16.8
Taper Ratio	0.5	0.5
Root Chord (ft)	16.0	11
Thickness Ratio	0.10	0.06
Dihedral (deg)	0	30
Incidence (deg)	0	variable
Airfoil	NACA 65-410	NACA 0006
	Aileron	Elap
Chord Ratio	0.3c	0.3c
Span Ratio	0.76 - 1.0	0.24 - 0.76
	Fuselage	Cockpit
Length (ft)	55.0	7.0
Max Height (ft)	7.0	5.2
Max Width (ft)	9.0	3.6

Fig. 3. A-2000.

Short take off and landing distances (1500 ft) are achieved by a combination of minimizing weight, the use of a single slotted flap covering over 50% of the wing span, and a leading edge extension (LEX) to increase lift. The LEX creates a strong vortex flow over the inward portion of the wing creating an additional nonlinear lift distribution. It also serves to strengthen the boundary layer, thus delaying flow separation and aiding high angle-of-attack flight performance. The vortex flow created by the LEX will also help to reduce the problem of gun gas ingestion into the engine by drawing the gas up over the top of the wing and away from the inlets. Auxiliary inlets above the wing open up for take-off while the primary inlets, which are below the wing, simultaneously close off. This considerably reduces the chances of foreign object damage to a turbine blade while operating on a rough, unprepared runway.

The A-2000 is highly maneuverable in the low-altitude, high-speed environment of close air support. Maneuverability is enhanced by moderate load factors (7.5 g), high afterburner thrust levels (27,500 lb static), and high lift coefficients. The use of strictly internal fuel tanks for all but the ferry mission helps keep parasite drag to a minimum.

The A-2000 is capable of providing support in a variety of roles. These include antiarmor, precision attack, battlefield interdiction, and maritime patrol. A variety of hardpoints are supplied for both weapons and external fuel tanks. The GAU-12 cannon in conjunction with armor-piercing rounds allows the A-2000 to defend against enemy tanks, armored vehicles, and a variety of ground targets, while offering a considerable weight savings over the GAU-8 specified in the request for proposal.

Keeping the level of complexity to a minimum has reduced the need for extensive ground support. An auxiliary power unit (APU) allows the A-2000 to self start, requiring smaller ground crews, while the use of proven technologies and readily accessible components minimizes the maintenance requirements.

**THE MANX**

The Manx fighter aircraft is offered as a viable replacement for existing close air support (CAS) aircraft, Fig. 4. The Manx is designed to outperform existing CAS aircraft by integrating

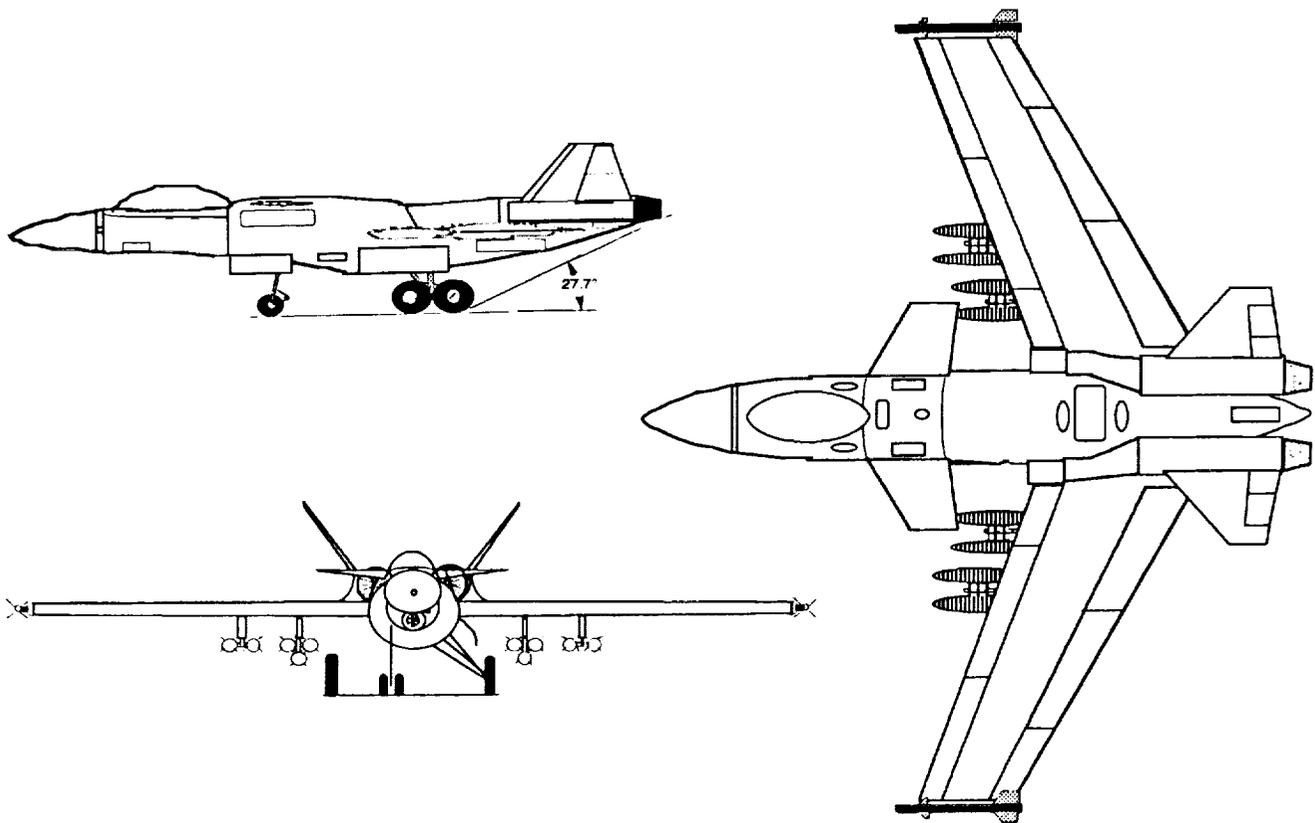


Fig. 4. Manx Fighter.

new technologies in aircraft configuration, avionics, weapons deployment, survivability, and maintainability.

The Manx's forward-swept wing, canard configuration will allow for a smaller, lighter-weight aircraft that is more efficient than existing aircraft. This configuration contributes to improved maneuverability, better stall characteristics, and offers a stable platform from which weapons can be aimed accurately.

The Manx incorporates an aeroelastically tailored, cantilever midwing that is swept forward  $25^\circ$  at the quarter chord. The wing airfoil section is a NACA 65-210. Additional lift for take off, landing, and maneuvering is achieved by integrating both Fowler flaps and leading edge slats.

The Manx fuselage has been designed with a fineness ratio of 8 to reduce drag. The fuselage is semimonocoque with aluminum-lithium frames, aluminum alloy longerons and composite skins.

The Manx is equipped with a canard that is a fully movable surface. This canard is primarily used for pitch control, but also enhances roll capability when used differentially in conjunction with the ailerons. The canards are also employed as a speed brake during landing.

Twin vertical tails provide the stability required for one-engine inoperative flight, well as giving the Manx the redundancy needed to survive in a high-threat environment. The swept cantilever tails are canted  $35^\circ$  to place them out of the wake of the fuselage at high angle of attack.

A tricycle landing gear is provided to allow the Manx added stability and ruggedness. The gear retracts forward. This design allows the gear to be deployed by gravity and locked into position by dynamic pressure in the case of power failure or damage. The nose gear is a dual arrangement while the main gear is a tandem design. The tires are low pressure to allow for operations from soft grass or packed sand fields.

The Manx is equipped with twin low-bypass turbojet power plants, each producing 16,000 lb of thrust at sea level. The engines produce power required to meet the required performance of the design and also provide redundancy in case of engine failure or damage. Engine inlets have been placed above the wing to reduce the possibility of foreign object damage to the engine.

The single pilot is situated in a forward-mounted air-conditioned and pressurized cockpit that has been designed

to increase pilot visibility. The cockpit is enclosed by single-piece polycarbonate canopy that opens upward. The pilot and all vital avionics are surrounded by a Kevlar shield which provides protection from small and medium ground fire.

The Manx employs a triple-redundant irreversible fly-by-wire control system to signal the electrohydrostatically driven control surfaces. The Manx also uses a stability augmentation system (SAS) to help the pilot control the 17.8% longitudinally unstable aircraft. Additional avionics used in the Manx include terrain following/avoidance radar/IR, global positioning satellite navigation and targeting, forward looking infrared (FLIR), and LANTIRN navigation/targeting pods.

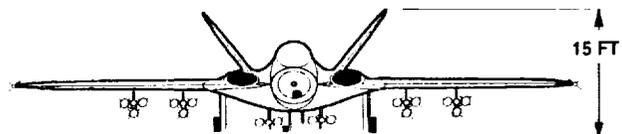
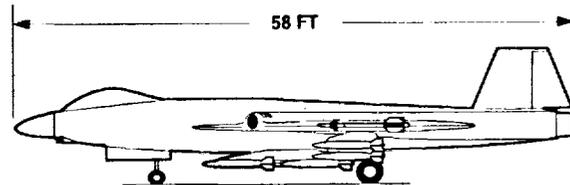
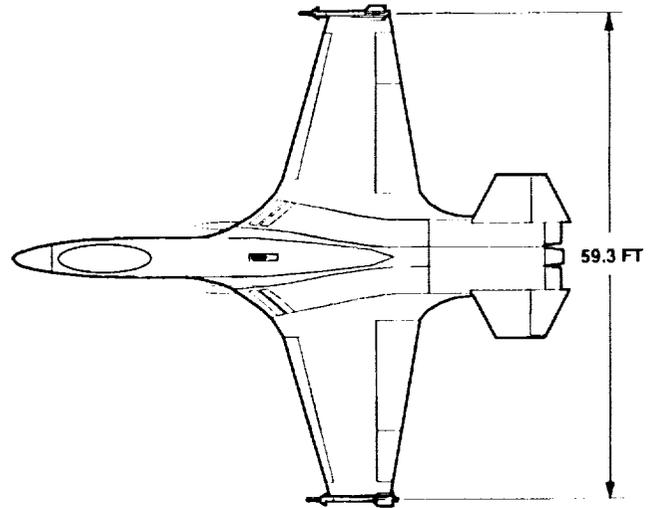
There are 10 hard points available for weapons carrying capability. AIM-9L Sidewinders are carried on each wing tip and 20 Mk-82 bombs are carried on 4 wing hard points for the design low-level mission. Other weapons can be integrated using the additional hard points as the missions require.

### THE CYCLONE

The future battlefield will require an effective close air support aircraft able to protect friendly troops and wreak destruction on the enemy. The Cyclone design group has produced an aircraft capable of these tasks.

The conventional configuration of the Cyclone reduces the costs that are incurred during the research and development phases of a new aircraft design, and the proven ability of this configuration in existing aircraft makes it a wise choice for the Cyclone, Fig. 5. The blended wing-fuselage reduces the interference drag and results in a greater fuselage volume allowing for all the required fuel to be carried in the fuselage. On top of this, the refueling port gives the Cyclone midair refueling capabilities, greatly extending its operational range and endurance. The engine inlets are set off the fuselage to minimize ingestion of gun gas produced by the GAU-8 30-mm cannon, and they allow for undisturbed flow into the engine intake. Furthermore, the small leading edge extensions inboard of the engine inlets create vortices that entrain the gun gas over the fuselage and further prevent gun gas ingestion into the engines. Use of the v-tail and an augmented flight control system reduces the structural weight and skin friction drag of the Cyclone. The bubble canopy used on the Cyclone provides excellent visibility for the pilot in all directions, allowing him to see possible threats or targets. The titanium tub surrounding the cockpit also increases the pilot's safety by protecting him from small arms fire.

The aerodynamics of the Cyclone include a supercritical airfoil to reduce the compressibility drag at higher Mach numbers. In conjunction with the leading edge flaps and trailing edge single-slotted flaps, this airfoil provides enough lift for the aircraft to allow it to land and take off in short distances. The wing configuration and large internal fuel volume of the Cyclone allow it to carry its large payload into battle even if the battlefield is far away. Furthermore, the design instability of the Cyclone makes it maneuverable, and as the fuel is consumed on the way to the battle the aircraft becomes even more maneuverable. The Cyclone's propulsion system includes two low-bypass, augmented turbofan engines buried inside the fuselage where they are protected. They provide an excellent dash speed at



#### MAIN WING PLANFORM GEOMETRY:

	SPECIFICATION
AIRFOIL	SUPER CRITICAL
ASPECT RATIO	5
C/A SWEEP ANGLE	8 DEGREES
THICKNESS RATIO	0.12
TAPER RATIO	0.35
WING SPAN	59.3 FT
SURFACE AREA	703.5 SQ FT

Fig. 5. Cyclone: A close air support aircraft for tomorrow.

sea-level for this type of aircraft and, with afterburner, the Cyclone has more than enough power for combat maneuvering.

In conclusion, the Cyclone is the choice for the future in close air support.

**THE RAPTOR**

The Raptor was designed around a cranked-arrow, canard, twin vertical tail configuration, Fig. 6. The cranked-arrow configuration was selected as the optimal blend of high-speed drag reduction and low-speed maneuverability. The wing employs single-slotted flaps and flaperons for additional lift capabilities and roll control. The canards are mounted on the upper surface of the inlets for minimal disruption of incoming airflow into the inlet. In addition, the canards can be independently controlled for supplementary roll control. The twin vertical tails give adequate engine-out control, even with one vertical tail inoperable. The Raptor sets down, after completing its mission, on a conventional tricycle landing gear configuration.

The wing structure is composed of six tapered spars, to decrease weight and increase survivability. The majority of the airframe is composed of aluminum for its high strength-to-weight ratio and ease of manufacturing. Composites are used sparingly in only the canard and vertical tails for their fatigue resistance in combatting buffeting at high angles of attack.

The Raptor performance is unequalled by any other competitor. With design weapons load, the Raptor launches off the runway in a mere 1605 ft. The Raptor will execute a normal landing in only 1124 ft, and land after an aborted takeoff in only 1800 ft. The Raptor can be ferried up to 3020 nmi on internal fuel alone. A sea-level combat radius with design weapons load of 475 nmi can be achieved. Acceleration from Mach 0.3 to Mach 0.5 is achieved in a neck-breaking time of 7.7 seconds. A 45,000 ft per min maximum rate of climb is attained by the Raptor at sea level. These two outstanding performance parameters combine to allow a combat pass (consisting of a 360° turn and 4000-ft energy increase) to be performed in 23.8 s, giving the Raptor one of the fastest reattack times possible. This top-of-the-line aircraft will cost the taxpayer a mere 12.6 million dollars.

Raptor Specifications	
Wing Area	500 ft <sup>2</sup>
Wingspan	45 ft
Ac <sub>in</sub> (inboard)	53°
Ac <sub>out</sub> (outboard)	26°
Overall Length	61.5 ft
Overall Height	17 ft
Canard Area	94 ft <sup>2</sup>
Vertical Tail Area	160 ft <sup>2</sup>
Empty Weight	22700 lbs
Design Weight	46500 lbs
Max Thrust	36500 lbs

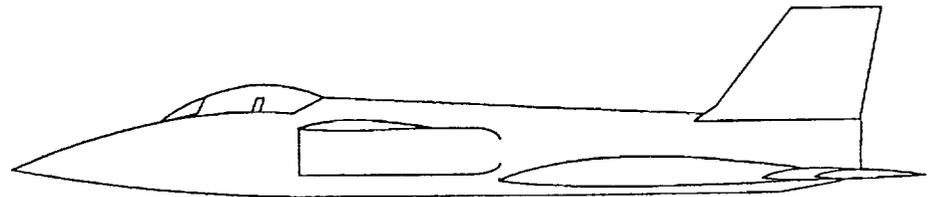
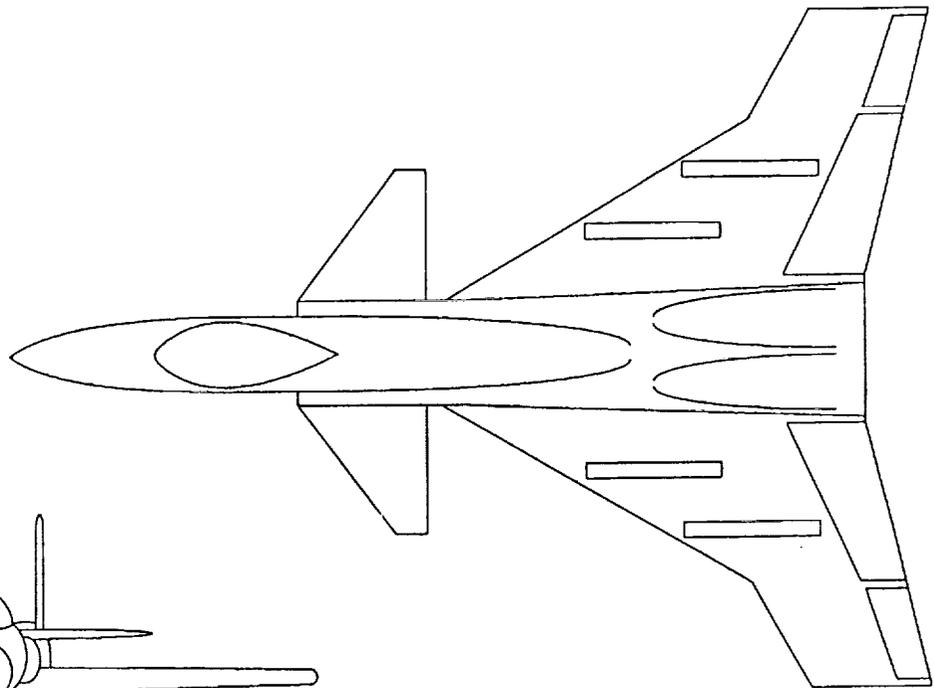
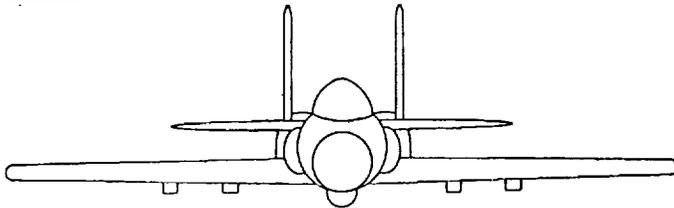


Fig. 6. The Raptor.

The cockpit was designed for maximum ease of use by the pilot by employing large reconfigurable multifunction displays. Also, the next generation of ejection systems is used in the form of the Boeing CREST ejection seat. Pilot visibility is excellent, with  $16^\circ$  over the nose and  $41^\circ$  over the side.

To enable day and night, as well as bad weather operations, the Raptor is equipped with an internally mounted LANTIRN targeting and navigation system. In addition, a Pave Penny sensor was included to allow for target handoff from friendly ground or air units. For protective measures, a flare and chaff system was placed in the rear of the aircraft between the two engines.

Battlefield maintenance and ground support is kept to a minimum by the inclusion of an auxiliary power unit and an airframe-mounted accessory drive. The canards and vertical tails are interchangeable by design for ease of replacement.

The awesome sight of a fully laden Raptor, carrying 36 Mk 82 bombs on its seven high-capacity hardpoints, is sure to strike fear into the hearts of even the most battle-hardened enemy commanders.

### THE SCORPION

Technology has caused battlefield warfare to become increasingly complex. The concept of the close air support aircraft has not changed, but the close air support aircraft and its role has had to continually evolve to maintain pace with the battleground. The primary goal of the Scorpion design team was to design an aircraft that met today's needs as well as fulfill tomorrow's. The design process resulted in an aircraft that is rugged, reliable, and capable of flying in adverse operating conditions. The Scorpion exceeds all mission requirements and is capable of fulfilling additional roles. The Scorpion excels in range, payload capabilities, and rate of climb.

The Scorpion has a conventional configuration, with twin tails, twin engines, and tricycle landing gear sized for rough field operation, Fig. 7. The wing is a conventional planform with a  $20^\circ$  leading edge sweep. The lift augmentation system includes leading edge slats, Fowler flaps, and flaperons. The horizontal tail is a fully controllable stabilator arrangement, also with a  $20^\circ$  leading edge sweep. The engines are separated to provide better survivability, and the inlets were placed high, on top of the wings, extending to the leading edge to provide uniform freestream flow and to help prevent foreign object ingestion during take-off and landing ground time. The Scorpion also features a bubble canopy for better pilot visibility— $20^\circ$  down the nose and  $45^\circ$  laterally. The location of the vertical tails, forward of the horizontal stabilators, allow for maximum simultaneous deflection of the rudders and stabilators as well as simplifying the internal structural layout of the empennage. The twin-canted vertical tails also allow for better survivability and increased controllability in high-angle-of-attack flight conditions.

The object of the Scorpion design concept was to produce a neutral or marginally stable close air support aircraft. The static margin of the Scorpion is 2% stable, which allows for excellent maneuverability with survivability. The aircraft is maneuverable, but controllable in the event of system failure. Through the use of a double-redundant fly-by-wire system, the survivability of the aircraft is further enhanced. Marginally stable

aircraft also offer the advantage of having minimal trim drag, as well as eliminating the need for complex avionics, thus minimizing costs. Other electronic systems used in the Scorpion include a passive infrared all-weather navigation and target acquisition system that also decreases the effectiveness of radar-seeking anti-aircraft weapons.

The aforementioned characteristics enhance the performance of the Scorpion. The performance parameters determined include specific excess power, range-payload capabilities, and the flight envelope. The Scorpion's maximum rate of climb at Mach 0.5 at sea-level is 12,500 fpm. The maximum range with payload is 2006 nmi and the maximum ferry range is 4300 nmi at a best cruise altitude of 38,000 ft. For a 4.5-g sustained turn, the maximum turn rate is  $17^\circ$  per sec at a turn radius of 1700 ft. This allows for a reattack time of 21 sec. The Scorpion is capable of taking off from a 1600 ft. hard, dry strip and can land within 1589 ft.

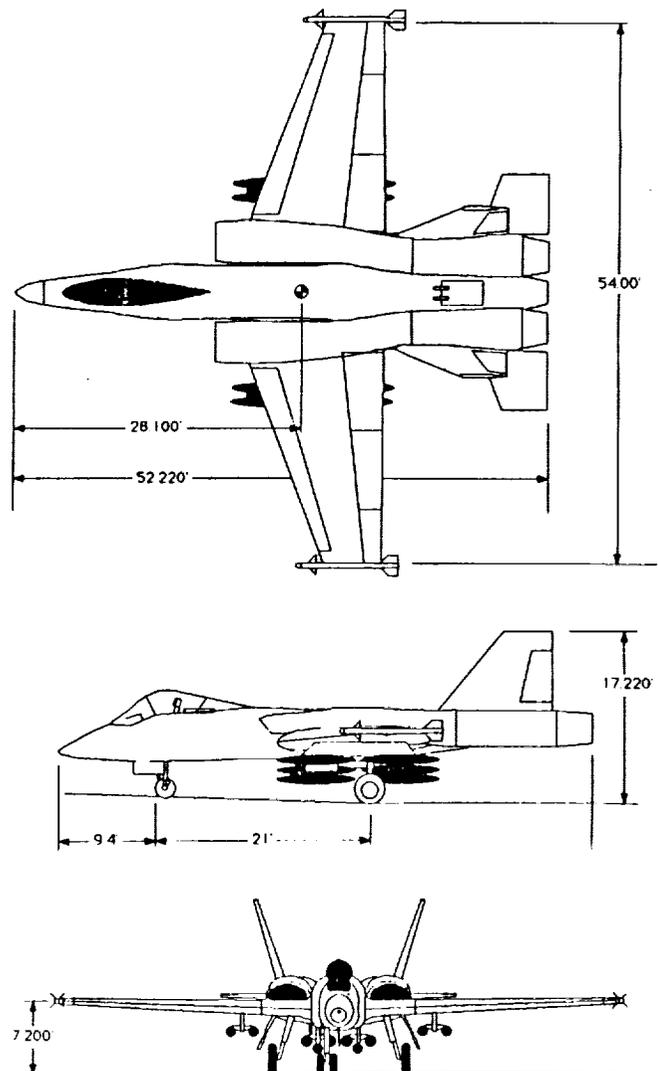


Fig. 7. Three-view of Scorpion.

The Scorpion was designed to meet the battlefield requirements of the future, while emphasizing low-cost (\$17.5 million 20-year life cycle cost), low-maintenance, high survivability, multirole capabilities, and low pilot workload to enhance combat performance.

### THE ELIMINATOR

The Eliminator is the answer to the need for an affordable, maintainable, survivable, high-performance close air support aircraft, Fig. 8. As important as close air support is, the U.S. is facing a desperate need for a new aircraft to fill this role. The challenge for the future will be to produce a close air support aircraft that will be able to stand up to a high-tech, fast moving, and incredibly deadly battlefield. In addition, the future aircraft must be versatile enough to adapt to any possible mission it might be called upon to perform during war or peacetime, with a minimum need for maintenance or service. Most importantly, the aircraft of the future must be affordable.

It is vital that it employ a combination of new and proven technologies to achieve a blend that gives high performance and survivability.

The Eliminator is a fixed-wing aircraft, with two GE F404-400 turbofan engines, and a high-canard, low-wing, twin-tail configuration aircraft. The total length of the aircraft is 55 ft, with a wingspan of 53 ft, and a total planform area of 517 ft<sup>2</sup>. Since the take-off weight is 55,000 lb, the maximum wing loading is 110 psf. The maximum thrust from the two engines with afterburners is 30,000 lb, making the maximum power loading at take-off 0.55. Without the afterburners, the maximum thrust is 22,000 lb. The afterburners provide the Eliminator with an excess power up to 300 ft/s. Without afterburners the Eliminator has up to 185 ft/s in excess power. This power was required to meet the 2000-ft ground roll requirement, and also provides maneuvering power in combat situations.

The main wing and the canard use a NACA 63-412 airfoil. The canard has been designed with a trailing edge extension, or TEX, in order to assure smooth flow into the engine inlets.

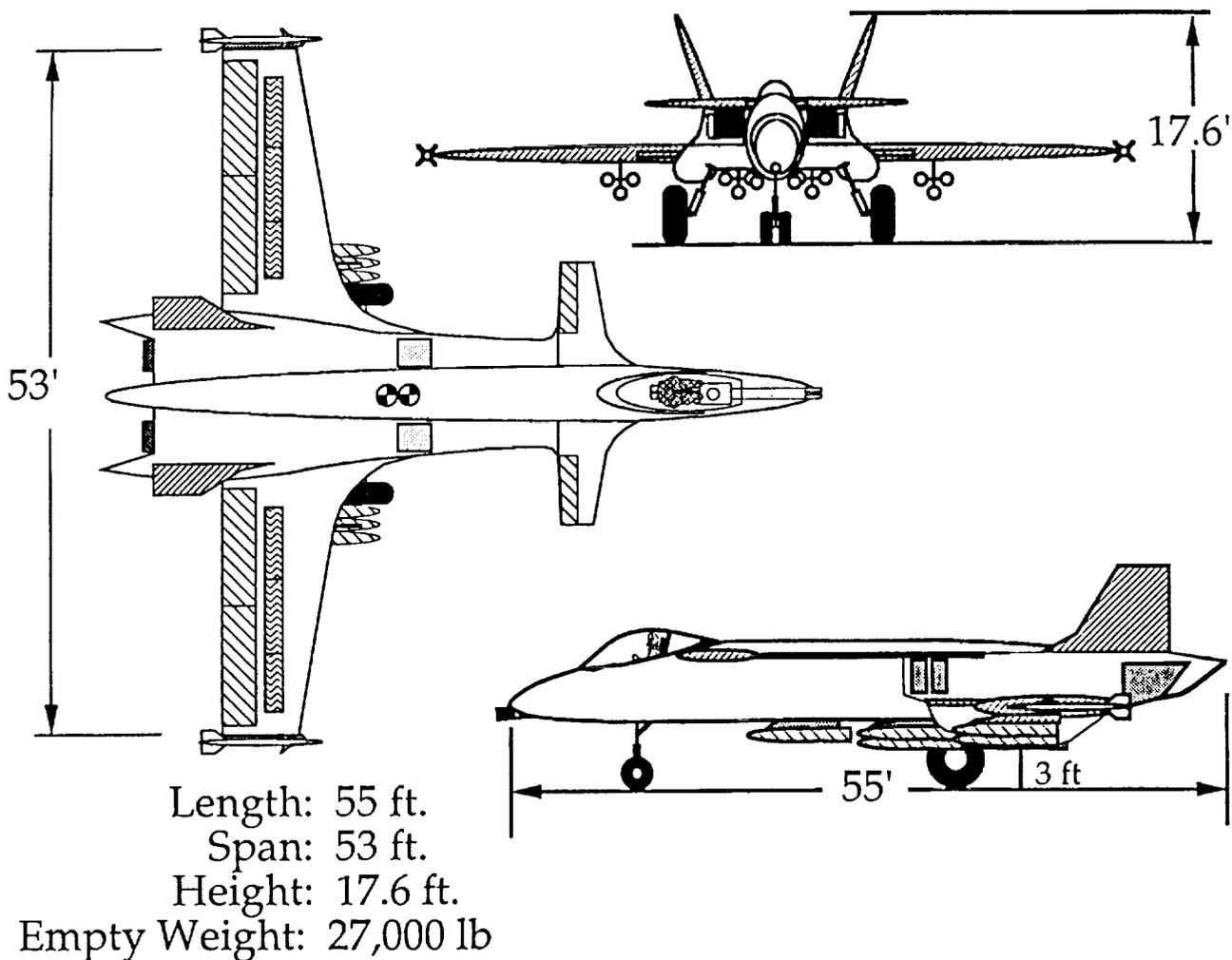


Fig. 8. Eliminator.

Pressure relief doors were added to the TEX, just behind the inlets, to release the air trapped at high angles of attack, and thus reduce the pressure buildup in front of the inlet. The doors should also act as vortex generators, producing vortices over the fuselage, thus increasing the lift of the fuselage slightly.

The main wing uses Fowler flaps to provide a high boost to the lift coefficient at take-off, enabling the Eliminator to exceed the runway length requirement of 2000 ft with a mere 1760 ft ground roll for take-off and 1810 ft for landing. Should it be necessary to land in a shorter distance, the pilot may employ the airbrakes, which are mounted directly on the side of the aircraft, extending from the trailing edge of the main wing to the rear of the fuselage. The tires of the Eliminator have been oversized, and inflated to approximately 65 psi, to allow operation from hard dirt runways. Operation from soft grass fields is possible with a temporary metal runway implemented.

The Eliminator has been designed to have a maximum instability of 23%, resulting in an extremely maneuverable aircraft. A dual fly-by-wire control system will therefore be employed to aid the pilot in maneuvering. The primary control system is powered by the generators. The secondary control system has been located as spatially distant from the primary wires as possible in order to avoid the destruction of both systems in the case of a hit. Should it be necessary, the pilot may use the secondary system, which is run either by the generators, the APU (both located between the engines), or the battery, located in the nose of the aircraft.

The avionics used by the Eliminator have been chosen for their usefulness and cost effectiveness. A radar system is not employed, primarily because it is not necessary for this type

of aircraft. In addition, extensive radar systems are typically very costly and it has been attempted to keep the cost of the Eliminator as low as possible. Therefore, for the purpose of target identification, a passive system has been chosen—the Pave Penny system, located under the center of the fuselage. For defensive purposes, a radar warning system (antennae located in the tail and nose) will be used to inform the pilot when to employ the chaff and flares for electronic countermeasures.

The Eliminator's primary mission is close air support, but it can easily be converted for antiarmor use. In addition, the Eliminator can do maritime patrols, antiradiation missions, and interdiction missions, among others. These different roles make the Eliminator a flexible and capable aircraft for all services.

One design objective was to keep the cost of the aircraft as low as possible. The Eliminator achieves this goal, with a flyaway cost of \$14.6 million. Included in this cost were the conventional aluminum alloys and composites of which the Eliminator is built, its relatively simple avionics systems, and the Eliminator's weight and maximum speed, among many other factors.

Although this is only a preliminary design, and much work and analysis would need to be done before the Eliminator could be considered a finished concept, there is a great deal of cause for enthusiasm. The Eliminator meets or surpasses all the requirements that drove its design and has emerged as a capable aircraft that can be used to fulfill many missions. Although designed for close air support, it has become evident that the Eliminator could fill many roles, and could be acquired as a single plane air force. This alone makes it a remarkable aircraft. The Eliminator: It's not a threat; it's a promise.